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## ON THE ANTISEPTIC ACTION OF FILLING-MATERIALS.

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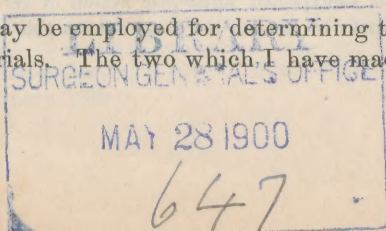
(Reprinted from the DENTAL COSMOS for December, 1889.)

It will scarcely be questioned by anyone acquainted with the nature of those diseases of the teeth which we treat by filling, that in a great many cases, if not in all, the probability of success would be greatly heightened if the filling-material could be made to exert a permanent antiseptic action upon the walls and margin of the cavity. This is more particularly true of all cases where, for some reason or other, carious dentine is left in the cavity at the time of filling; and such cases constantly occur in every dental practice. There are, I hope, very few practitioners in dentistry who place so high an estimate upon their own skill and thoroughness, or so far overlook the imperfection in the structure of the dentine, as to imagine that they excavate every cavity perfectly. Many even *prefer* leaving a thin layer of softened dentine in the cavity to removing it, if the pulp would thereby be exposed. Others, no doubt, for very humane reasons, sometimes excavate less thoroughly than they otherwise would do, in order to spare their patient the excessive pain accompanying the operation, or because the patient cannot or will not bear the pain. Most of us, for the sake of our backs, toward the end of a hard day's work, now and then decide that a difficult cavity is ready to fill when a careful examination of it might still reveal soft points. It is not necessary, however, to enumerate other cases in which the preparation of the cavity is not quite faultless; most readers will no doubt be able to suggest many more.

Now, it may appear remarkable that, while so much attention has of late years been bestowed upon the antiseptic treatment of root-canals and the employment of antiseptic materials for filling them, very little attention has been given to the subject of the antiseptic materials for filling cavities of decay; iodoform cement being, as far as I know, the only material which was introduced with this object in view. That it does not accomplish its object will, I think, be apparent from the experiments recorded below.

### METHODS.—I.

Various methods may be employed for determining the antiseptic action of filling-materials. The two which I have made use of are



exceedingly simple, and at the same time very instructive. In applying the first of these methods we proceed as follows: A tube of ordinary nutritive gelatine is infected with a bacterium from the oral cavity, which grows rapidly at room temperature without liquefying the gelatine. The gelatine is then melted, slightly shaken, so as to distribute the fungi equally throughout the solution, and poured upon a horizontal sterilized glass plate, upon which we drop pieces of the filling-material or other substances whose antiseptic action we wish to determine. As soon as the gelatine becomes stiff we place the plate in a damp chamber. A plate prepared in this way, without the addition of any material having an antiseptic action, will become cloudy and opaque in the course of twenty-four to forty-eight hours, through the development of in-

FIG. 1.



An inoculated gelatine plate containing : a, pieces of oxyphosphate cement one day old ; b, pieces of gold amalgam one day old ; c, pieces of an old copper amalgam filling, age unknown ; d, pieces of stained dentine from a tooth which had been filled many years previously with copper amalgam.

numerable colonies of bacteria. If, however, the pieces of filling-materials which we have dropped upon the plate possess an antiseptic action, the development of the fungi in their neighborhood will be retarded or altogether prevented, and each piece will appear surrounded by an area of transparent gelatine whose size will depend upon the activity of the antiseptic employed. Most of the filling-materials in use were tested by this method in respect to the antiseptic action, with the result that the only one which possesses such action and retains it for an indefinite time after it has been inserted is copper amalgam.\* Not only freshly-mixed fillings, but pieces of

\* Regarding an unexpected antiseptic action of certain preparations of gold which might appear to furnish an exception to this rule, see the experiments described below.



old, half-worn-out fillings, taken from teeth extracted in the polyclinic of the Dental Institute, and even pieces of *dentine* from teeth which had been filled with copper amalgam, invariably manifested a retarding or preventing action upon the growth of bacteria. (Fig. 1.)

These results accord exactly with those which I obtained by entirely other methods in 1884 (*Independent Practitioner*, June), and which have been called in question by Bogue and others.

Of course it must not be inferred from these remarks that a little piece of copper amalgam dropped into a litre of bouillon will keep it from spoiling. Nor would an experiment of this nature be a just test of the antiseptic action of a material used in filling.

If the filling prevents the progress of decay in softened dentine under it or in immediate contact with it, and if it retards the progress of fermentation in fine spaces (leakages) between it and the marginal wall, then it is doing a great deal toward preventing the recurrence of caries, which another filling not possessing antiseptic properties would not do.

That so much is accomplished by copper amalgam, I am, I believe, justified in concluding from the experiments enumerated above, and more particularly from those made under the second method and described below. It is a view, moreover, pretty generally accepted by all operators who have had opportunity of observing the action of copper amalgam fillings, that they do possess a preserving action upon tooth-substance. I, along with most others, formerly accounted for this action upon the supposition that copper amalgam does not shrink while setting. I meet almost daily with amalgam fillings, not containing copper, which admit of the point of an excavator being inserted between the filling and the margin of the cavity, whereas copper amalgam fillings appear to hug the walls of the cavity perfectly. Elliott,\* however, found by a very extended series of experiments that copper amalgams do contract, and some of them to a surprising degree. Elliott's results are corroborated by the evidence of J. Boyd Wallis,† who claims that the slight contraction is a distinct advantage in the case of soft and sensitive teeth, because of the more speedy formation of the oxide or sulphide, which, being absorbed by the surrounding dentine, protects it from further progress of decay. "Pulps dying under copper amalgam fillings do not so readily decompose, owing to their becoming charged with antiseptic cupric salts."

Other materials experimented with by the first method were gold amalgam, oxychloride of zinc (agate cement), oxyphosphate of zinc (Caulk's cement), gutta-percha, gold, tin, and tin-gold.

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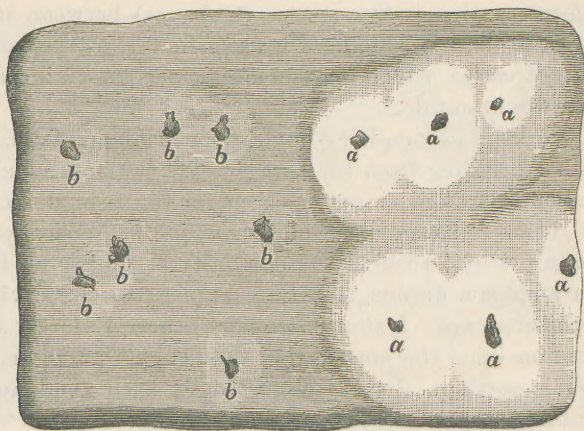
\* Transactions of the Odontological Society of Great Britain, December, 1888.

† *Dental Record*, February, 1889.

Gold amalgam, freshly mixed, caused a slight retardation in the development of fungi; old pieces had no effect. Oxychloride of zinc, fresh, had a very marked action (see Fig. 2). Pieces which had lain twenty-four hours in saliva and bread lost their antiseptic power. Oxyphosphate of zinc, fresh, had a slight, inconstant action (Fig. 2), sometimes none at all. After twenty-four hours' exposure in a mixture of saliva and bread, it showed no action whatever; gutta-percha and tin proved completely inactive.

The results obtained with gold were very peculiar and perplexing. Some preparations of gold manifest a decided restraining effect upon the development of bacteria, so that if a pellet is dropped upon the plate it will after twenty-four to forty-eight hours appear surrounded by a perfectly round circle of transparent gelatine, sepa-

FIG. 2.



An inoculated gelatine plate containing pieces of freshly-mixed cement. *a*, oxychloride; *b*, oxyphosphate. A very marked hindrance in the development of the fungi is noted around the pieces of oxychloride; around the pieces of oxyphosphate it is scarcely perceptible. Plate twenty-four hours old.

rated from the clouded gelatine by a sharp border. Within this zone the fungi develop very slowly, so that the cloudiness appears much later than on other parts of the plate. The antiseptic action of Pack's pellets was particularly marked. Plugs of the unannealed pellets made in holes bored in wood showed considerable action, even after they had lain for forty-eight to seventy-two hours in a mixture of saliva and bread. Also Abbey's soft foil and quarter-century foil showed similar action, but in a somewhat less degree. Other preparations showed varied effects; some had almost or quite none at all. *This action was completely destroyed by annealing the gold beforehand* (Fig. 3). Some preparations of sponge gold and platinum gold acted in a similar manner, and even old gold fillings now and then showed considerable antiseptic action.

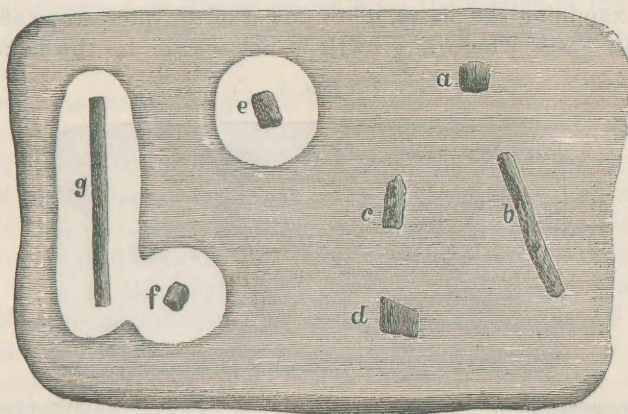


I shall not attempt to give any explanation for these facts now. Different explanations suggest themselves, none, however, with which I have been quite satisfied. Nor will I at present endeavor to answer the question whether the action is strong enough to be entitled to any consideration as a saving property of unannealed gold. I am inclined to think that it would be rather venturesome to assert that it is.

Tin-gold was less active than gold alone.

I applied this method of testing the antiseptic property of filling-materials to a few other substances; among them to iodoform, which did not have the slightest action in checking the growth of the fungi.

FIG. 3.



Inoculated gelatine plate containing Pack's pellets and Abbey's foil No. 4, folded to make strips of No. 32. a, b, c, d, annealed; e, f, g, unannealed. The latter have retarded the growth of the fungi in their neighborhood, as is shown by the gelatine remaining clear. Plate twenty-four hours old.

## II.

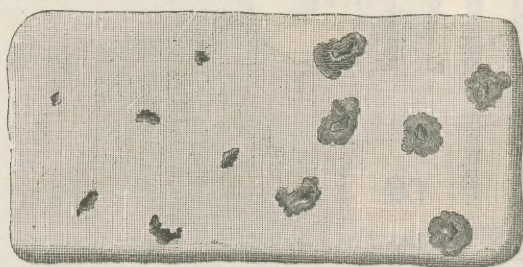
In order to make a direct test of the action of fillings upon carious dentine or upon the micro-organisms contained in it, we proceed as follows: A number of freshly-extracted teeth which are extensively decayed, not, however, so as to expose the pulp, are cleansed of the remains of food, and only partially excavated, so as to leave a thick layer of carious dentine in each cavity.

The cavities are then filled with various substances whose antiseptic action we wish to test, and the teeth placed in a mixture of saliva and bread and kept for three days at a temperature of 30° C. to 40° C. At the end of this time they are taken out, washed in pure water, placed for a moment in sublimate 1-1000, then in a larger quantity of sterilized water to remove the sublimate, after which they are dried with sterilized bibulous paper. We then take

the teeth by the root or roots, rest the side of the crown upon a small anvil, and strike a sharp blow upon it with a hammer. The filling flies out, exposing the untouched surface of carious dentine. We now with a sterilized spoon-shaped excavator remove a small piece of the carious dentine and place it upon a previously prepared plate of sterile nutritive agar-agar. The plate is then put away in a moist chamber at or near the temperature of the human body. If now the fungi in the carious dentine have been killed by the action of the filling-material, or if the dentine has been so acted upon by the material as itself to become antiseptic, no fungi will develop around it; otherwise we will find in the course of forty-eight to sixty hours that the piece of dentine becomes surrounded by a zone of fungous growth of varying extent.

In examining the plates, a low power of the microscope should be used in cases where a growth is not visible to the naked eye.

FIG. 4.



A sterile agar-agar plate, containing in the left half pieces of dentine from a cavity which had been filled with copper amalgam, in the right half pieces from a cavity which had been filled with gold amalgam. The former have remained sterile, whereas an extensive growth of fungi has taken place around the latter. Plate three days old.

Furthermore, a slight cloudiness or precipitate which sometimes forms around pieces impregnated with copper salts must not be mistaken for a fungous growth; and lastly, a development of bud-fungi (yeast-fungi, *Saccharomycetes*), or mold-fungi (*Hyphomycetes*), which is very frequently observed, must not be mistaken for fission-fungi (*Schizomycetes*).

The following materials were examined by this method:

1. Copper amalgam (Lippoldt's). Fifteen teeth were treated as described, and the carious dentine examined by culture. In not a single case did a development of bacteria take place. They had either been devitalized or the dentine itself had become antiseptic. In two cases, bud-fungi developed; in one case, mold-fungi.

2. Gold amalgam, ten teeth. In all cases a development of bacteria took place around the dentine, to say nothing of bud- and mold-fungi (Fig. 4).



3. Oxyphosphate, eight teeth. Result same as with gold amalgam.

4. Oxychloride of zinc, eight teeth. In seven cases a growth of bacteria formed, though very much retarded when compared with the oxyphosphate or gold amalgam. In one case the piece remained sterile.

5. Iodoform powder mixed with phosphate cement, one tooth. Development of fungi unchecked. In another case the floor of the cavity was covered with powdered iodoform and oxyphosphate filled over. Pieces of dentine taken from the cavity after three days and transferred to the culture plate were soon surrounded by a growth of bacteria and bud-fungi.

6. Powdered sulphate of copper incorporated with cement or with gutta-percha, or simply strewn upon the bottom of the cavity before filling, nine teeth. No trace of bacterial growth appeared in any case.

From these results we are forced to the conclusion that copper amalgam fillings exert a marked antibacterial influence upon the walls of the cavities containing them, that oxychloride cements have an appreciable though markedly less effect, and that oxyphosphate and gold amalgam are wanting in any such action. We learn, furthermore, that by incorporating certain antiseptics into the mass of the filling or covering the bottom of the cavity before inserting the filling we may produce an effect analogous to that of copper amalgam.

Can any application of these results be made in practice? I think so, though I am certainly not in favor of being over-hasty in drawing conclusions.

Personally, I have always had much faith in the preservative properties of copper amalgam fillings, because I have had abundant opportunity to observe the splendid results obtained by its use even when very little care was taken in its insertion. The experiments which I have made have naturally served to strengthen my confidence in this material, in consequence of which I have used it to some extent in my practice in the last year. At the cervical margin I often put a layer of copper amalgam, and then fill the rest of the cavity with some other material. In cases of complicated caries extending under the gum and very near the pulp, where phosphate fillings are utterly unreliable, and even combined with gutta-percha often very unsatisfactory, and where it is not considered wise to risk a permanent filling at once, I protect the neck of the tooth by copper amalgam, allowing a very thin layer to extend over the floor of the cavity in order to thoroughly sterilize the dentine and keep it sterile. I then fill the remaining part of the cavity with cement

or gutta-percha, with the intention, in case all goes well, of replacing it in some months by a permanent material.

Where, however, I am inclined to believe that the use of antiseptic materials may be accompanied by excellent results is for capping exposed pulps, particularly when they are not in a healthy condition, or contain germs of infection, as well as for covering the floor of the cavity in all cases where the pulp is protected by but a thin layer of dentine, which is very often more or less softened, if not infected with bacteria. For this purpose sulphate of copper, incorporated with gutta-percha or with some soft cement like oxysulphate, would, I am convinced, go far to effectually sterilize the thin layer of dentine covering the pulp, and thereby to prevent not only the decomposition of such softened dentine as may have been left over the pulp, but also the infection of the latter, which is very often the case of pulp-troubles arising under fillings.

The sulphate of copper, however, seriously stains dead teeth in the course of three days, and would probably act with equal rapidity upon living teeth, so that its use would be on that account very much restricted, if not altogether contraindicated.

Various substances suggest themselves, which, being incorporated with cement or gutta-percha, might do good service as antiseptic dressings over diseased pulps or over softened dentine; first of all, naturally, the bichloride of mercury. Which of the many available antiseptics, however, is best adapted to the purpose must be determined by further experiments in the laboratory and in practice.

The practice of treating exposed pulps, whether healthy or diseased, to a bath of concentrated carbolic acid has been sharply criticised by various writers. There are nevertheless many practitioners in high standing who treat all exposures of the pulp in this manner, and claim to obtain better results than by any other method. I will not venture to say that this may not be so, because the ill effects of so severely cauterizing the pulp-tissue may be balanced by the good effects of thorough antiseptic treatment. If we, however, could attain the same object by the use of less irritating agents, our probability of success would be much greater.

Further experiments relating to this subject are now in progress, and will be reported in due time.